Session 10 Overview

mm-Wave and Beyond

Chair: Ali Hajimiri, California Institute of Technology, Pasadena, CA

Associate Chair: Hiroyuki Sakai, Matsushita Electric, Osaka, Japan

The frequency bands at high microwave and millimeter-wave (mm-wave) frequencies such as 24GHz, 60GHz, and 77GHz offer new opportunities and challenges for gigabit wireless local area networks and automotive radar. Gigabit data rates are becoming an essential necessity due to the emergence of broadband high-quality video and audio applications, as well as high-speed home and enterprise networking. The migration to higher mm-wave frequencies facilitates the integration of more functionality in silicon and allows for spatially reconfigurable communication systems that can reuse bandwidth in a dynamic and more efficient fashion. Millimeter-wave silicon ICs can also enable low cost beam-forming automotive radar at 77GHz that will substantially improve the safety and reliability of next generation cars, enabling features such as self-parking, collision avoidance, preemptive brake boosting, low-visibility driving aid, and autonomous cruise control in both low- and high-end cars. Successful demonstration of a phased-array system in silicon with on-chip antennas can make such luxuries a reality. The propagation challenges at higher frequencies are overcome by using phased-array multiple-antenna systems on both the receiver and the transmitter. The integration of the antenna with the rest of the receiver eliminates the last high-frequency electrical connection to the chip, making it the ultimate fully integrated communication system in silicon. This session explores the most recent developments in mm-wave applications of silicon and offers a broad set of solutions for broadband communications and automotive radar.

Paper 10.1 demonstrates a fully integrated 4-element phased-array receiver with on-chip antennas in silicon, including the entire down-conversion chain, power combining and phase generation functions with no external mm-wave connection. Each of the four elements achieves a noise figure of 8dB over the system bandwidth of 3GHz at 77GHz.

A 77GHz transmitter phased array with continuous phase shifting, where each element has a gain of 40dB and an output power of +12.5dBm, demonstrating successful beam-steering at 77GHz, is shown in Paper 10.2.

Paper 10.3 describes an integrated receiver-transmitter pair operating at 60GHz in silicon. The receiver has a NF of 6dB and the transmitter has 10 to 12dBm 1dB compression point and 10% PAE in the output stage.

A 60GHz transmitter with integrated tapered-slot antenna is shown in Paper 10.4. It integrates a VCO, a sub-harmonic mixer, and a PA on a chip and achieves 20dB of conversion gain while consuming 281mW of dc power.

Paper 10.5 describes a digitally controlled LC oscillator that is integrated in a digital 65nm CMOS process. The VCO achieves 10% tuning range with a phase noise of -102dBc/Hz at 1MHz offset while drawing 3.3mA from a 1.1V supply.

 1-4244-0079-1/06/$20.00

10.1 A 77GHz 4-Element Phased-Array Receiver with On-Chip Dipole Antennas in Silicon **10:15 AM**
A. Babakhani, California Institute of Technology, Pasadena, CA

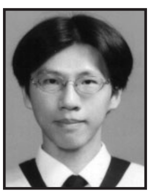
On-chip antennas are used in a fully integrated phased-array receiver at 77GHz. The complete down-conversion, power-combining, and phase-generation functions are integrated in silicon with no external mm-wave electrical connections. Each of the 4 receiver elements has 41dB of gain with a NF of 8dB with a system BW of 3GHz.

10.2 A 77GHz Phased-Array Transmitter with Local LO-Path Phase-Shifting in Silicon **10:45 AM**
A. Natarajan, California Institute of Technology, Pasadena, CA

A fully integrated 77GHz 4-element phased-array transmitter in 0.12μm SiGe BiCMOS based on a continuous local phase shifting approach is presented. Each element generates +12.5dBm output power at 77GHz and has 34dB gain from baseband to RF with a bandwidth of 2.5GHz. The chip demonstrates successful beam-steering at 77GHz.

10.3 A 60GHz Receiver and Transmitter Chipset for Broadband Communications in Silicon **11:15 AM**
B. Floyd, IBM Research, Yorktown Heights, NY

An integrated SiGe superheterodyne RX/TX pair capable of Gb/s data rates in the 60GHz band is described. The 6dB NF RX includes an image-reject LNA, a multistage down-converter with on-chip IF filters, a frequency tripler, a PLL, and baseband outputs. The 10 to 12dBm P_{1dB} TX achieves 10% PAE in the final stage. It includes a PA, image-reject driver, multistage up-converter with on-chip filters, tripler, and PLL.



10.4 A 60GHz Transmitter with Integrated Antenna in 0.18μm SiGe BiCMOS Technology **11:45 AM**
C-H. Wang, National Taiwan University, Taipei, Taiwan

A 60GHz SiGe HBT transmitter IC with integrated antenna in a standard-bulk 0.18μm SiGe BiCMOS process is reported. This chip is composed of a VCO, a sub-harmonic mixer, a PA, and a tapered-slot antenna, all with differential designs. The measured results show 15.8dBm output power and 20.2dB conversion gain with 281mW dc power consumption.

10.5 A 10b 10GHz Digitally Controlled LC Oscillator in 65nm CMOS **12:00 PM**
N. Da Dalt, Infineon, Villach, Austria

A digitally controlled LC oscillator (DCO) is integrated in a digital 65nm CMOS technology. The frequency can be fine tuned with 10b from 9.87 to 10.92GHz (10%) with a frequency step of 1.03MHz/LSB. The DCO draws 3.0mA from a 1.1V supply and achieves a phase noise of -102dBc/Hz at 1MHz offset (FOM=-177.2dBc/Hz).